

A NEW AUBRITE BASALT VITROPHYRE FROM THE LEW87007 AUBRITE. Robert A. Fogel, American Museum of Natural History, Department of Earth and Planetary Sciences, New York, NY 10024.
{bobby@amnh.org}

INTRODUCTION: The process of aubrite formation from a reduced protolith approximating an E chondrite composition is only vaguely understood. One of the key materials that is missing is the basalts from which aubrites crystallized. Fogel (1994) [1] published preliminary data on two Aubrite Basalt Vitrophyres [ABV's] that are good candidates for some of the basalts that gave rise to the aubrites. In the intervening period, a search has been undertaken to find other ABV's. A new ABV has been found in the Antarctic aubrite LEW87007. In many respects the texture and composition of this inclusion (termed L87I) complements that of the other two ABV's: KTI, from the Khor Temiki aubrite and PAI from the Parsa EH3 chondrite [1]. As the third ABV discovered, L87I's potential to supply new information regarding aubrite formation is only fully appreciated when used in conjunction with the other ABVs previously reported.

Analytical: Section LEW87007,4 was examined with an optical microscope and an SEM for textural and qualitative compositional data. Quantitative electron microprobe analyses were conducted on the AMNH-LDEO SX100 microprobe equipped with 5 movable spectrometers. Physical conditions were 15 KeV and between 6 and 40 nAmps current depending on the material.

RESULTS: L87I is located at one end of the polished thin section and approximates a trapezoid in geometry. The inclusion is about 8 x 3.5 mm in size and has a vitrophyric igneous texture distinct from that of the neighboring aubrite. L87I is predominantly composed of euhedral enstatite crystals (≈ 85 vol %) ranging up to 700 μm in size; although crystals on the order of 100 μm are more typical. Diopside is the other important silicate mineral present (≈ 5 vol %). It is found as anhedral to euhedral crystals that are evenly distributed in the clast and range up to 150 μm in size. Silicate glass (≈ 10 vol %) is distributed throughout the clast and is commonly found as thin films of varying thicknesses between the pyroxenes. Larger lenses of silicate glass are also common but rarely reach more than 100 μm in diameter. Troilite (≈ 0.5 vol %) is present as an accessory phase and is commonly found, with kamacite (trace) or separately, as small blebs within and between silicate phases.

Pyroxenes are reduced and low in FeO as expected from an aubrite; however, the FeO contents of the enstatite (0.6 ± 0.2 wt %) and diopside (0.4 ± 0.1 wt %) are higher than typical aubrite (< 0.2 wt % [2]). The small amounts of kamacite and

troilite in the rock eliminates Fe secondary fluorescence as the cause for the elevated FeO. Enstatites are otherwise relatively pure with only trace MnO (0.17 ± 0.05 wt %) and CaO (0.12 ± 0.06 wt %). In contrast, diopside is impure: $\text{TiO}_2 = 0.3 \pm 0.1$; $\text{Al}_2\text{O}_3 = 0.4 \pm 0.1$; $\text{CrO} = 0.12 \pm 0.02$; $\text{MnO} = 0.6 \pm 0.06$; $\text{Na}_2\text{O} = 0.2 \pm 0.05$ (all in wt %). Diopside compositions range from $\text{Di}_{80}\text{En}_{20}$ to $\text{Di}_{48}\text{En}_{52}$ with a mean of $\text{Di}_{65}\text{En}_{35}$. Most of this range, including the mean, falls squarely within the one atm diopside-enstatite solvus (all T's). This suggests that L87I diopsides have either submicron exsolution of enstatite or are metastable. The problem is being investigated further.

Silicate glass compositions (Table 1) are granitic and fall along the albite-silica join. (FeO, TiO_2 , CaO and MgO together total to about 0.8 wt %). The glasses are slightly peraluminous (Molar $\text{Na}_2\text{O} + \text{K}_2\text{O} + \text{CaO} / \text{Al}_2\text{O}_3 = 0.85$); although this deviation from metaluminosity may be the result of alkali-loss during EPMA analysis (15 KeV; 6 nA; 5 μm beam diameter, 10 sec used). The composition of L87I troilite is distinctive in its trace quantity of Ti ($0-0.17$ wt %). Troilites are nearly pure with minor Cr (0.4 ± 0.1 wt %). In contrast, the Ti content of the troilite in the surrounding aubrite ranges from 0.5 to 1.4 wt % (mean = 0.9 ± 0.1 wt %). Cr in the surrounding aubrite (0.5 ± 0.03 wt %) is essentially identical to L87I. Trace kamacite has $\text{Ni} = 1.9 \pm 0.3$ wt %, $\text{Co} = 0.14 \pm 0.02$ wt % and $\text{Cr} = 0.14 \pm 0.11$ wt %. Kamacite Si content in L87I is below probe detectability; however, this is not uncommon for aubrites [2].

DISCUSSION: A projection of both the bulk composition and glass composition of L87I onto the Forsterite-Albite-Silica phase diagram shows that both compositions lie close to or directly on cotectic lines (Fig. 1). This is also the case with PAI and KTI [1 & Fig. 1]. L87I *glass compositions* lie along the albite-silica cotectic, with the mean composition lying close to the cotectic center between the quartz-albite-enstatite eutectic and the albite-enstatite-forsterite peritectic (coplanarity). The *bulk composition* lies on the enstatite-forsterite reaction boundary close to the 1525°C isotherm. As in the case of PAI and KTI, the glass composition can be interpreted as representing the composition of the silicate liquid at the time of last equilibration; i.e., immediately before quench of the rock. Similarly, the bulk composition can be interpreted as the composition of the liquid from which L87I crystallized.

The bulk compositions of the three ABV's L87I, KTI and PAI share the common feature of lying along the enstatite-forsterite reaction boundary and have liquidi between 1480 and 1525°C (Fig. 1). On the other hand, KTI and PAI appear to be snapshots of liquids whose crystallization proceeded only along the enstatite-forsterite reaction boundary and were frozen by quench along this boundary at ≈1330°C (Fig. 1). In contrast, L87I cooled much further and terminated along the albite-enstatite cotectic at ≈1080°C. Additionally, diopside crystallized along this path. (The proper diagram for interpreting L87I glass composition is the diopside saturated Fo-Ab-Qz system; however, the distortion in using Fig. 1 is not great and allows for comparison to PAI and KTI.)

There is, however, a major difference between L87I and KTI-PAI. Although reduced, L87I appears to be more oxidized than the other two ABVs, or for that matter, aubrites in general. Evidence for this includes: 1) the lack of cubic sulfides such as CaS, MnS-MgS, 2) the lack of Ti in troilite, 3) the presence of Mn, Ti and Cr in L87I diopside (very

reducing conditions should have partitioned these elements predominantly into sulfides), 4) minor element quantities of FeO in enstatite as opposed to trace quantities in nominal aubrites [2], 5) lack of high S contents in the silicate glass (S in PAI and KTI silicate glass equals 0.8 and 2.6 wt %, respectively [1]). This suggests that L87I either a) experienced some form of oxidation event during its petrogenesis, or b) is the product of melting of a bulk composition similar to E chondrite but not quite as reduced.

As with KTI and PAI, the lack of high shock features in L87I, the rationalized phase equilibria and the high alkali contents suggests that L87I is the product of igneous melting of an E chondrite-like source material.

REFERENCES: [1] Fogel (1994) *Meteoritics* 29, 466-467; [2] Watters and Prinz (1979) *Proc. Lunar Planet. Sci. X*, 1073-1093.

Table 1. L87I Silicate Glass.

Oxide	(Wt %)	(σ)
SiO ₂	74.13	(0.66)
TiO ₂	0.24	(0.05)
Al ₂ O ₃	16.61	(0.34)
FeO	0.15	(0.15)
MnO	b.d.	
CrO	b.d.	
MgO	0.26	(0.09)
CaO	0.20	(0.07)
Na ₂ O	7.76	(0.50)
K ₂ O	0.98	(0.07)
S	0.08	(0.03)
Total	100.41	
N	25	

b.d. = below detection

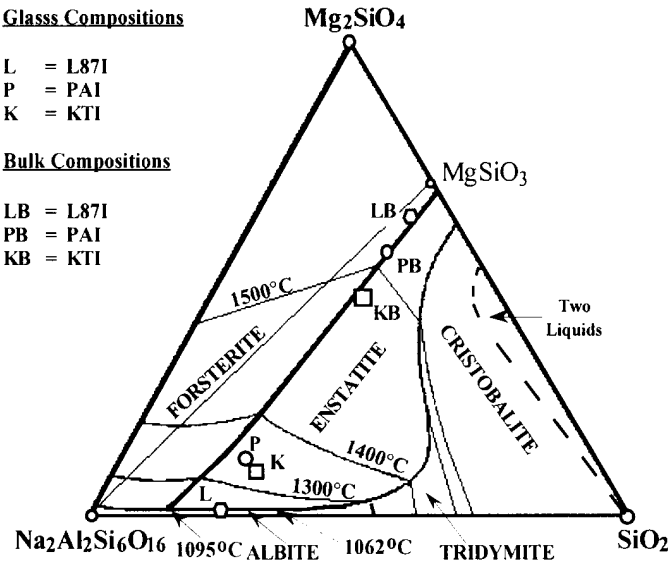


Fig. 1. Forsterite-albite-silica system (weight basis).